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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/880,975	06/13/2001	Thomas J. Sonderman	2000.045300	5882

23720 7590 10/25/2004

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EXAMINER	
KIELIN, ERIK J	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 10/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/880,975	SONDERMAN ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 August 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) *2-6,13-21 and 23-31* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,7-12 and 22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This action responds to the Amendment filed 6 August 2004.

Specification

1. The amendment filed 23 August 2004 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: The Amendment to the specification removes admissions of prior art and accordingly introduces new matter. These portions must not be removed.

Applicant is required to cancel the new matter in the reply to this Office Action.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 7-12, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,428,673 B1 (**Ritzdorf** et al.) in view of US 6,221,765 B1 (**Ueno**) and US 6,298,470 B1 (**Breiner** et al.).

Regarding claims 1 and 22, **Ritzdorf** discloses a method for controlling a thickness of an electroplated copper layer for **damascene** and **dual damascene** structures (col. 3, lines 10-21; col. 5, line 17) using feedback from metrology comprising,

forming a first copper layer;

measuring an actual thickness of the copper layer "**and/or other parameters**" (col. 9, lines 52-54);

comparing the actual thickness to a desired thickness; and

varying at least one parameter used to form the first copper layer in response to the actual thickness differing from the desired thickness **and the "other parameters."** (See Abstract; col. 3, line 64 to col. 4, line 15; col. 4, lines 37-65; col. 5, lines 2-5; col. 7, lines 36-45; col. 8, lines 49-53.)

Ritzdorf does not indicate that the mechanical stress relating to said first copper layer is measured and used for process control but, as noted, **Ritzdorf** suggests measurement of "other parameters" (called "metrology data") of the copper layer and the used of the measured other parameters to feedback or feed forward process control (*inter alia* at col. 9, lines 50-65).

Ueno teaches an electroplated damascene copper structure (e.g. in Fig. 1) wherein compressive stress is intentionally introduced into the copper layer during fabrication to prevent void generation (col. 3, lines 23-48).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to measure and use for process control (in the claim language "varying at least one parameter used to form the first copper layer in response to) the mechanical stress in order to ensure and to control the quantity of compressive stress in the copper layer to thereby prevent stress-induced

voiding, as taught by **Ueno** -- especially since **Ritzdorf** suggests measuring other parameters of the copper layer and use the measured parameters for process feedback and feed forward control.

Both **Ritzdorf** and **Ueno** are drawn to electroplated damascene copper interconnect for semiconductor device fabrication and therefore, one of ordinary skill is ensured a reasonable expectation of success in combining the references.

Ritzdorf does not describe the damascene process disclosed therein.

Ueno teaches the basic copper damascene process known to one of ordinary skill also includes the formation of the dielectric with the opening, or in Applicant's claim language,

forming a first dielectric layer **2** above a first structure layer **1**;

forming a first opening **5** in the first dielectric layer **2** (called "trench patterning and "via patterning");

forming a first copper layer **6** above the first dielectric layer **2** and in the first opening **5**.

(See Ueno Figs. 1-5.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to form the damascene structure in **Ritzdorf**, according to steps indicated in **Ueno**, because **Ritzdorf** says a damascene structure is used and **Ueno** teaches and/or defines the notoriously well known steps for forming the damascene structure.

Then the only difference is that **Ritzdorf** does not teach the limitation that measuring the actual thickness of the copper layer comprises, "averaging a plurality of thicknesses from a plurality of locations" on said first copper layer.

Breiner teaches a method of process control during semiconductor fabrication by feedback from metrology tools (col. 3, lines 25-67) citing specific examples, wherein the data,

including the thickness of deposited metal layers (col. 4, lines 20-25), is data that may be used to provide process control feedback. It is further stated therein that,

> "The wafer data may be collected and tracked on a per wafer basis, per lot basis, per process run basis or combinations thereof. Further, the data may include **multiple measurements for each data point**, **mean values**, **median values**, range of values, standard deviations, **wafer maps** of the collected data, etc." (col. 4, lines 60-65).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to "average a plurality of thicknesses from a plurality of locations" in determining the uniformity in **Ritzdorf**, in order to make the "wafer map" of thickness which shows the thickness globally and also provides a visual mapping of the uniformity, as taught in **Breiner**.

Regarding claim 7, it is seen to be inherent that the actual thickness is measured at a plurality of locations, because **Ritzdorf** indicates that the uniformity is determined thereby requiring the thickness determination at several points. (See MPEP 2112.)

Regarding claims 8 and 9, the prior art of **Ritzdorf**, as explained above, discloses each of the claimed features except for indicating that the measuring of the thickness at a plurality of locations includes determining the average or median of the actual measured thickness.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the average or median (called "mean" in **Breiner**) of the plurality of points measured in **Ritzdorf** as taught in **Breiner** because the average or median values would provide a more precise measure of the thickness over the entire wafer than would a collection of un-analyzed or un-reduced thickness measurements.

Regarding claims 10-12, the prior art of **Ritzdorf**, as explained above, discloses each of the claimed features except for indicating that the measuring of the thickness at a plurality of

locations, inherently disclosed in **Ritzdorf**, includes comparing the desired thickness to each of the plurality of measured thicknesses (claim 10) or comparing the desired thickness to the average (claim 11) or median values (claim 12) of the thickness.

As noted above, **Breiner** teaches that the any of the above-highlighted data (each of the plurality of thicknesses, the average thickness, or the median thickness) provide feedback for process control. Feedback necessarily requires comparison of measured data to some desired value, otherwise there would exist no direction in which to modify the process to move in the direction of the desired value, and consequently no control could be provided. Moreover, **Breiner** provides examples of process control based upon feedback of measured thickness (col. 6, lines 15-32 and col. 7, lines 15-38).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to compare the measured data (each of the plurality of thicknesses, the average thickness, or the median thickness) as taught by **Breiner** in the method of **Ritzdorf**, because **Ritzdorf** indicates that thickness and uniformity are data used to modify the process of depositing copper and because **Breiner** teaches that any of the measured data (each of the plurality of thicknesses, the average thickness, or the median thickness) may be used to provide feedback (i.e. comparison to a desired value) for process control.

4. Claims 1, 7, 8, 10, 11, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,428,673 B1 (**Ritzdorf** et al.) in view of US 6,221,765 B1 (**Ueno**) and US 6,211,094 B1 (**Jun** et al.; reference provided by Applicant in the IDS filed 27 August 2003 [Paper no. 16]).

Regarding claims 1 and 22, **Ritzdorf** discloses a method for controlling a thickness of an electroplated copper layer including damascene layers (col. 3, lines 10-21) using feedback from metrology comprising,

forming a first copper layer;

measuring an actual thickness of the copper layer;

comparing the actual thickness to a desired thickness; and

varying at least one parameter used to form the first copper layer in response to the actual thickness differing from the desired thickness. (See Abstract; col. 3, line 64 to col. 4, line 15; col. 4, lines 37-65; col. 5, lines 2-5; col. 7, lines 36-45; col. 8, lines 49-53.)

Ritzdorf does not indicate that the mechanical stress relating to said first copper layer is measured and used for process control but, as noted, **Ritzdorf** suggests measurement of "other parameters" (called "metrology data") of the copper layer and the used of the measured other parameters to feedback or feed forward process control (*inter alia* at col. 9, lines 50-65).

Ueno teaches an electroplated damascene copper structure (e.g. in Fig. 1) wherein compressive stress is intentionally introduced into the copper layer during fabrication to prevent void generation (col. 3, lines 23-48).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to measure and use for process control (in the claim language "varying at least one parameter used to form the first copper layer in response to) the mechanical stress in order to ensure and to control the quantity of compressive stress in the copper layer to thereby prevent stress-induced voiding, as taught by **Ueno** -- especially since **Ritzdorf** suggests measuring other parameters of the copper layer and use the measured parameters for process feedback and feed forward control.

Both **Ritzdorf** and **Ueno** are drawn to electroplated damascene copper interconnect for semiconductor device fabrication and therefore, one of ordinary skill is ensured a reasonable expectation of success in combining the references.

Ritzdorf does not describe the damascene process disclosed therein.

Ueno teaches the basic copper damascene process known to one of ordinary skill also includes the formation of the dielectric with the opening, or in Applicant's claim language,

forming a first dielectric layer **2** above a first structure layer **1**;

forming a first opening **5** in the first dielectric layer **2** (called "trench patterning and "via patterning");

forming a first copper layer **6** above the first dielectric layer **2** and in the first opening **5**.

(See Ueno Figs. 1-5.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to form the damascene structure in **Ritzdorf**, according to steps indicated in **Ueno**, because **Ritzdorf** says a damascene structure is used and **Ueno** teaches and/or defines the notoriously well known steps for forming the damascene structure.

Then the only difference is that **Ritzdorf** does not teach the limitation that measuring the actual thickness of the copper layer comprises, "averaging a plurality of thicknesses from a plurality of locations" on said first copper layer.

Jun teaches a method of process control during semiconductor fabrication by feedback from metrology tools (Abstract; Figs. 4A-4B), specifically including "averaging a plurality of thicknesses from a plurality of locations" to determine the actual thickness of the deposited layer

--as further limited by instant claim 8-- and using this data to provide process control feedback to adjust the deposition process parameters (col. 4, lines 20-67 -- especially "TABLE 1").

It would have been obvious for one of ordinary skill in the art, at the time of the invention to "average a plurality of thicknesses from a plurality of locations" to provide process feedback data in **Ritzdorf**, in order to better control the deposition process, as taught in **Jun**.

Regarding claim 7, it is seen to be inherent that the actual thickness is measured at a plurality of locations, because **Ritzdorf** indicates that the uniformity is determined thereby requiring the thickness determination at several points. (See MPEP 2112.)

Regarding claims 10 and 11, comparing the actual thickness to the desired thickness comprises comparing the desired thickness to each of the plurality of measure thicknesses (**Jun** Table 1 --especially the footnote to Table 1) and also comparing the desired thickness to the average thickness (col. 4, last paragraph).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to "average a plurality of thicknesses from a plurality of locations" to provide process feedback data in **Ritzdorf**, in order to better control the deposition process, as taught in **Jun**.

Response to Arguments

5. Applicant's arguments filed 6 August 2004 have been fully considered but they are not persuasive.

Applicant's speculation about that which the Ritzdorf patent is directed, are acknowledged. Examiner notes with interest that Applicant's summary of Ritzdorf ignores that Ritzdorf is specifically directed to using metrology to control the copper deposition in copper

damascene and dual damascene metallization. Applicant's speculation regarding the teachings in Ueno and Breiner are noted too. In this regard, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Applicant argues,

> "Ueno does not disclose modifying a parameter by measuring a stress, which is a missing element that the Examiner uses Ueno to provide."

Examiner respectfully submits that Applicant has grossly distorted the rejection provided in the Office action of 17 May 2004. Ueno is NOT provided for "**measuring** a stress." Rather Ueno is provided for showing why knowing the **specific quantity** of stress in a copper layer is important, i.e. to prevent stress-induced voiding, as taught by Ueno. Ritzdorf says that "other parameters" may be measured for feedback control. Ergo one of ordinary skill would combine the beneficial teachings of Ueno and measure the stress as adjust based upon said measurement, as suggested to do in Ritzdorf, to ensure the proper quantity of stress to prevent voids in the deposited copper. Accordingly, Applicant's argument is not found persuasive since it misinterprets the use of Ueno. Examiner respectfully submits that the combination of Ueno is proper under *Graham v. Deere* analysis.

Applicant's arguments regarding Breiner are based upon the first false premise that

> "the 'number of points' reference in Breiner refers to the number of positions in the fabrication process, not the number of points on the semiconductor wafer itself."

While it is noted that Breiner makes this statement, Breiner also states,

> "the data may include multiple measurements for each data point..." (col. 4, lines 62-63).

This clearly does not refer to the points in the fabrication but, instead, specifically to the measure data itself.

Applicant's arguments regarding Breiner are based upon the second false premise that, " 'multiple measurements for each data point' refers to a plurality of measurements of each point of data of interest (e.g., a point of data of interest); it does not refer to multiple measurements at different points on a semiconductor wafer." Examiner respectfully disagrees. A wafer map is an infinity of points over a wafer.

Applicant's arguments regarding Breiner are based upon the third false premise that, "[t]he term 'wafer map' as disclosed in Breiner refers to electrical test characteristics..." Examiner respectfully disagrees. Breiner expressly includes thickness measurement. The number and types of data that are collected specifically include thickness (Breiner, col. 4, lines 4-65 -- especially lines 16-17, 20-25, and 60-65). Examiner will, however, consider **evidence** provided by Applicant proving that Breiner is somehow contradicting the express teachings therein to specifically exclude thickness measurements.

Applicant argues that the combination of Ritzdorf with Ueno and Jun does not teach all of the features of the instant invention. Examiner respectfully disagrees for reasons indicated in the rejection above. All features are taught or suggested. Accordingly, the arguments are not found persuasive.

Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Erik Kielin
Primary Examiner
21 October 2004